

WHAT IS CLAIMED IS:

- 1                   1.       A device for enhancing a surgical procedure on a knee, the device  
2 comprising:  
3                   at least one stationary femoral member for removably attaching to a distal  
4 femur; and  
5                   at least one adjustable femoral member movably coupled with the stationary  
6 member to adjust tension in at least one ligament of or adjacent the knee, the adjustable  
7 femoral member comprising at least one positioning feature that moves relative to the distal  
8 femur as the adjustable femoral member is adjusted and thus identifies at least one position  
9 on the distal femur for facilitating completion of the surgical procedure to enhance at least  
10 one of range of motion, stability and patella tracking of the knee,  
11                  wherein the adjustable femoral member is movably couplable with at least one  
12 tibial member engaged with a proximal tibia to allow the knee to be moved through a range  
13 of motion without removing the femoral and tibial members.
- 1                   2.       A device as in claim 1, wherein the at least one stationary femoral  
2 member is engageable with a cut surface at the distal end of the distal femur.
- 1                   3.       A device as in claim 1, wherein the adjustable femoral member is  
2 separately adjustable on a medial side and a lateral side of the femoral member to adjust  
3 tension in the at least one ligament.
- 1                   4.       A device as in claim 3, wherein adjusting on one side relative to the  
2 other side causes the adjustable femoral member to rotate relative to the distal femur.
- 1                   5.       A device as in claim 4, wherein the adjustable femoral member  
2 comprises:  
3                   at least one lateral adjustment member for adjusting a lateral portion of the  
4 adjustable member; and  
5                   at least one medial adjustment member for adjusting a medial portion of the  
6 adjustable member.

1                   6.       A device as in claim 5, wherein the lateral and medial adjustment  
2 members are selected from the group consisting of screws, pins, levers, rods, springs, spring-  
3 loaded mechanisms and shape memory materials.

4                   7.       A device as in claim 3, wherein the at least one adjustable femoral  
5 member comprises:  
6                   at least one distal femoral portion for emulating a distal surface of the femur;  
7 and  
8                   at least one posterior condylar portion to emulate posterior condylar surfaces  
9 of the femur.

1                   8.       A device as in claim 7, wherein the at least one posterior condylar  
2 portion comprises:  
3                   a medial femoral posterior condylar portion; and  
4                   a lateral femoral posterior condylar portion.

1                   9.       A device as in claim 8, wherein the distal femoral portion, the medial  
2 femoral posterior condylar portion, and the lateral femoral posterior condylar portion all  
3 comprise one piece or extrusion.

1                   10.      A device as in claim 8, wherein the at least one stationary femoral  
2 member comprises:  
3                   at least one distal femoral plate for coupling the distal femoral portion of the  
4 adjustable femoral member to the distal femur; and  
5                   at least one posterior condylar member extending from the distal femoral  
6 portion to contact at least part of a medial posterior femoral condyle and a lateral posterior  
7 femoral condyle of the distal femur.

1                   11.      A device as in claim 10, wherein the at least one posterior condylar  
2 member comprises:  
3                   a medial femoral posterior condylar member; and  
4                   a lateral femoral posterior condylar member.

1                   12.     A device as in claim 11, wherein the distal femoral plate, the medial  
2 femoral posterior condylar member, and the lateral femoral posterior condylar member all  
3 comprise one piece or extrusion.

1                   13.     A device as in claim 11, wherein the medial femoral posterior condylar  
2 portion of the adjustable femoral member is adjustable relative to the medial femoral  
3 posterior condylar member of the stationary femoral member, and wherein the lateral femoral  
4 posterior condylar portion of the adjustable femoral member is separately adjustable relative  
5 to the lateral femoral posterior condylar member of the stationary femoral member.

1                   14.     A device as in claim 7, wherein the at least one posterior condylar  
2 portion of the adjustable femoral member is movably couplable with one or more  
3 complementary depressions in the tibial member.

1                   15.     A device as in claim 14, wherein the at least one posterior condylar  
2 member comprises:  
3                   a medial femoral posterior condylar member slidably couplable with a medial  
4 depression of the tibial member; and  
5                   a lateral femoral posterior condylar member slidably couplable with a lateral  
6 depression of the tibial member.

1                   16.     A device as in claim 1, wherein the adjustable femoral member is  
2 adjustable relative to the stationary femoral member to separately adjust tension in at least  
3 one of a medial collateral ligament and a lateral collateral ligament of the knee.

1                   17.     A device as in claim 1, wherein the at least one adjustable femoral  
2 member comprises at least one self-adjusting member.

1                   18.     A device as in claim 17, wherein the at least one self-adjusting member  
2 comprises at least one of a spring-loaded member and a shape memory member.

1                   19.     A device as in claim 17, wherein the at least one self-adjusting member  
2 adjusts relative to the stationary femoral member to adjust tension in at least one of a medial  
3 collateral ligament and a lateral collateral ligament of the knee.

1                   20.     A device as in claim 1, wherein the at least one adjustable femoral  
2 member comprises a plurality of pre-adjusted femoral members, each having a different  
3 asymmetry relative to the stationary member, wherein one of the pre-adjusted members is  
4 selected for facilitating the surgical procedure to provide a desired range of motion when the  
5 surgical procedure is completed.

1                   21.     A device as in claim 1, wherein the at least one positioning feature of  
2 the adjustable femoral member is selected from the group consisting of an aperture, a drill bit  
3 guide, a surface marker, a surface feature, a measurement device, an embedded marker, a  
4 fiducial, a transponder, a transceiver and a sensor.

1                   22.     A device as in claim 21, wherein the at least one positioning feature  
2 facilitates at least one of placing a cutting guide on the distal femur for making bone cuts,  
3 making one or more bone cuts on the distal femur, and positioning a prosthetic femoral  
4 component on the distal femur.

1                   23.     A device as in claim 21, wherein the at least one positioning feature  
2 comprises at least two apertures

1                   24.     A device as in claim 23, wherein each of the at least two apertures is  
2 configured to guide a drill bit to form a hole in the distal femur for attaching a cutting guide  
3 to the femur.

1                   25.     A device as in claim 23, wherein each of the at least two apertures are  
2 configured to receive at least one of a marker, a fiducial, a transponder, a transceiver and a  
3 sensor.

1                   26.     A device as in claim 23, wherein the at least two apertures extend  
2 through the adjustable femoral member and through apertures in the stationary femoral  
3 member to the distal femur.

1                   27.     A device as in claim 26, wherein the at least two apertures are  
2 positioned slightly asymmetrically on the adjustable femoral member to provide for a built-in  
3 desired flexibility in the ligaments when the surgical procedure is completed.

4                   28.     A device as in claim 21, wherein at least one of the adjustable femoral  
5 member and the positioning feature(s) is asymmetrically oriented relative to the stationary  
6 member to provide built-in enhanced range of motion when the surgical procedure is  
7 completed.

1                   29.     A device as in claim 28, further comprising multiple adjustable  
2 femoral members, each having a different asymmetry relative to the stationary member,  
3 wherein one of the multiple adjustable femoral members is selected for facilitating the  
4 surgical procedure to provide a desired range of motion when the surgical procedure is  
5 completed.

1                   30.     A device as in claim 1, wherein the at least one tibial member is  
2 engageable with a cut surface of the proximal tibia.

1                   31.     A device as in claim 30, wherein the at least one tibial member  
2 comprises at least one shim, paddle, plate, bar, platform or rod.

1                   32.     A device as in claim 31, wherein the at least one tibial member  
2 comprises a plurality of tibial shims having different thicknesses or heights, wherein any one  
3 of the plurality of shims may be selected for engaging with the cut surface of the proximal  
4 tibia to provide a desired amount of tension in the ligaments.

1                   33.     A device as in claim 32, wherein the at least one tibial member further  
2 comprises a plate for removably attaching to the cut surface of the proximal tibia, disposed  
3 between the cut surface and the selected tibial shim.

4                   34.     A device as in claim 1, wherein the femoral member and the tibial  
5 member are movably coupled via force provided by the at least one ligament of or adjacent  
6 the knee.

1                   35.     A device as in claim 1, wherein the femoral and tibial members, when  
2 engaged with the distal femur and proximal tibia respectively, are disposed primarily within a  
3 joint space between the distal femur and the proximal tibia.

1           36.     A device as in claim 35, wherein a patella of the knee remains  
2 approximately in its anatomical position while the femoral and tibial members are engaged  
3 and the knee is moved through the range of motion.

1           37.     A device as in claim 1, wherein the movable coupling of the femoral  
2 and tibial members allows for flexion and extension through the range of motion.

1           38.     A device as in claim 37, wherein the range of motion comprises a  
2 range from approximately full extension of the knee to approximately full flexion of the knee.

1           39.     A device as in claim 1, wherein the stationary femoral member  
2 comprises at least one material selected from the group consisting of plastics, composites,  
3 aluminum, stainless steel, composite, cobalt-chrome, titanium, and other metals.

1           40.     A device as in claim 1, wherein the adjustable femoral member  
2 comprises at least one material selected from the group consisting of plastics, composites,  
3 aluminum, stainless steel, composite, cobalt-chrome, titanium, and other metals.

1           41.     A device as in claim 1, further comprising at least one grasping  
2 member coupled with at least one of the stationary and adjustable femoral members for  
3 facilitating placement and/or removal of the device from the knee.

4           42.     A system for enhancing a surgical procedure on a knee, the system  
5 comprising:

6                 at least one femoral member removably engageable with a distal femur, the  
7 femoral member comprising:

8                     at least one stationary member for attaching to the distal femur; and

9                     at least one adjustable femoral member movably coupled with the

10 stationary member to adjust tension in at least one ligament of or adjacent the knee, the

11 adjustable femoral member comprising at least one positioning feature that moves relative to

12 the distal femur as the adjustable femoral member is adjusted and thus identifies at least one

13 position on the distal femur for facilitating completion of the surgical procedure to enhance at

14 least one of range of motion, stability and patella tracking of the knee; and

15 at least one tibial member removably engageable with a proximal tibia and  
16 movably couplable with the femoral member to allow the knee to be moved through a range  
17 of motion without removing the femoral and tibial members.

1 43. A system as in claim 42, wherein the at least one stationary femoral  
2 member is engageable with a cut surface at the distal end of the distal femur.

1 44. A system as in claim 42, wherein the adjustable femoral member is  
2 separately adjustable on a medial side and a lateral side of the femoral member to adjust  
3 tension in the at least one ligament.

1 45. A system as in claim 44, wherein adjusting on one side relative to the  
2 other side causes the adjustable femoral member to rotate relative to the distal femur.

1 46. A system as in claim 45, wherein the adjustable femoral member  
2 comprises:  
3 at least one lateral adjustment member for adjusting a lateral portion of the  
4 adjustable member; and  
5 at least one medial adjustment member for adjusting a medial portion of the  
6 adjustable member.

7 47. A system as in claim 44, wherein the at least one adjustable femoral  
8 member comprises:  
9 at least one distal femoral portion for emulating a distal surface of the femur;  
10 and  
11 at least one posterior condylar portion to emulate posterior condylar surfaces  
12 of the femur.

1 48. A system as in claim 47, wherein the at least one posterior condylar  
2 portion comprises:  
3 a medial femoral posterior condylar portion; and  
4 a lateral femoral posterior condylar portion.

1 49. A system as in claim 48, wherein the distal femoral portion, the medial  
2 femoral posterior condylar portion, and the lateral femoral posterior condylar portion all  
3 comprise one piece or extrusion.

1                   50.     A system as in claim 49, wherein the at least one stationary femoral  
2 member comprises:  
3                   at least one distal femoral plate for coupling the distal femoral portion of the  
4 adjustable femoral member to the distal femur; and  
5                   at least one posterior condylar member extending from the distal femoral  
6 portion to contact at least part of a medial posterior femoral condyle and a lateral posterior  
7 femoral condyle of the distal femur.

1                   51.     A system as in claim 50, wherein the at least one posterior condylar  
2 member comprises:  
3                   a medial femoral posterior condylar member; and  
4                   a lateral femoral posterior condylar member.

1                   52.     A system as in claim 51, wherein the distal femoral plate, the medial  
2 femoral posterior condylar member, and the lateral femoral posterior condylar member all  
3 comprise one piece or extrusion.

1                   53.     A system as in claim 51, wherein the medial femoral posterior  
2 condylar portion of the adjustable femoral member is adjustable relative to the medial  
3 femoral posterior condylar member of the stationary femoral member, and wherein the lateral  
4 femoral posterior condylar portion of the adjustable femoral member is separately adjustable  
5 relative to the lateral femoral posterior condylar member of the stationary femoral member.

1                   54.     A system as in claim 50, wherein the at least one posterior condylar  
2 portion of the adjustable femoral member is movably couplable with one or more  
3 complementary depressions in the tibial member.

1                   55.     A system as in claim 54, wherein the at least one posterior condylar  
2 member comprises:  
3                   a medial femoral posterior condylar member slidably couplable with a medial  
4 depression of the tibial member; and  
5                   a lateral femoral posterior condylar member slidably couplable with a lateral  
6 depression of the tibial member.



1           56.     A system as in claim 42, wherein the adjustable femoral member is  
2 adjustable relative to the stationary femoral member to separately adjust tension in at least  
3 one of a medial collateral ligament and a lateral collateral ligament of the knee.

1           57.     A device as in claim 42, wherein the at least one adjustable femoral  
2 member comprises at least one self-adjusting member.

1           58.     A device as in claim 57, wherein the at least one self-adjusting member  
2 comprises at least one of a spring-loaded member and a shape memory member.

1           59.     A device as in claim 57, wherein the at least one self-adjusting member  
2 adjusts relative to the stationary femoral member to adjust tension in at least one of a medial  
3 collateral ligament and a lateral collateral ligament of the knee.

1           60.     A device as in claim 42, wherein the at least one adjustable femoral  
2 member comprises a plurality of pre-adjusted femoral members, each having a different  
3 asymmetry relative to the stationary member, wherein one of the pre-adjusted members is  
4 selected for facilitating the surgical procedure to provide a desired range of motion when the  
5 surgical procedure is completed.

1           61.     A system as in claim 42, wherein the at least one positioning feature of  
2 the adjustable femoral member is selected from the group consisting of an aperture, a drill bit  
3 guide, a surface marker, a surface feature, a measurement device, an embedded marker, a  
4 fiducial, a transponder, a transceiver and a sensor.

1           62.     A system as in claim 61, wherein the at least one positioning feature  
2 facilitates at least one of placing a cutting guide on the distal femur for making bone cuts,  
3 positioning actual bone cuts on the distal femur, and positioning a prosthetic femoral  
4 component on the distal femur.

1           63.     A system as in claim 61, wherein the at least one positioning feature  
2 comprises at least two apertures

1           64.     A system as in claim 63, wherein each of the at least two apertures is  
2 configured to guide a drill bit to form a hole in the distal femur for attaching a cutting guide  
3 to the femur.

1                   65.     A system as in claim 63, wherein each of the at least two apertures are  
2 configured to receive at least one of a marker, a fiducial, a transponder, a transceiver and a  
3 sensor.

1                   66.     A system as in claim 63, wherein the at least two apertures extend  
2 through the adjustable femoral member and through apertures in the stationary femoral  
3 member to the distal femur.

1                   67.     A system as in claim 66, wherein the at least two apertures are  
2 positioned slightly asymmetrically on the adjustable femoral member to provide for a built-in  
3 desired flexibility in the ligaments when the surgical procedure is completed.

4                   68.     A system as in claim 61, wherein at least one of the adjustable femoral  
5 member and the positioning feature(s) is asymmetrically oriented relative to the stationary  
6 member to provide built-in enhanced range of motion when the surgical procedure is  
7 completed.

1                   69.     A system as in claim 68, further comprising multiple adjustable  
2 femoral members, each having a different asymmetry relative to the stationary member,  
3 wherein one of the multiple adjustable femoral members is selected for facilitating the  
4 surgical procedure to provide a desired range of motion when the surgical procedure is  
5 completed.

1                   70.     A system as in claim 42, wherein the at least one tibial member is  
2 engageable with a cut surface of the proximal tibia.

1                   71.     A system as in claim 70, wherein the at least one tibial member  
2 comprises at least one shim, paddle, plate, bar, platform or rod.

1                   72.     A system as in claim 71, wherein the at least one tibial member  
2 comprises a plurality of tibial shims having different thicknesses or heights, wherein any one  
3 of the plurality of shims may be selected for engaging with the cut surface of the proximal  
4 tibia to provide a desired amount of tension in the ligaments.

1           73.     A system as in claim 72, wherein the at least one tibial member further  
2 comprises a plate for removably attaching to the cut surface of the proximal tibia, disposed  
3 between the cut surface and the selected tibial shim.

4           74.     A system as in claim 42, wherein the femoral member and the tibial  
5 member are movably coupled via force provided by the at least one ligament of or adjacent  
6 the knee.

1           75.     A system as in claim 42, wherein the femoral and tibial members,  
2 when engaged with the distal femur and proximal tibia respectively, are disposed primarily  
3 within a joint space between the distal femur and the proximal tibia.

1           76.     A system as in claim 75, wherein a patella of the knee remains  
2 approximately in its anatomical position while the femoral and tibial members are engaged  
3 and the knee is moved through the range of motion.

1           77.     A system as in claim 42, wherein the movable coupling of the femoral  
2 and tibial members allows for flexion and extension through the range of motion.

1           78.     A system as in claim 77, wherein the range of motion comprises a  
2 range from approximately full extension of the knee to approximately full flexion of the knee.

1           79.     A system as in claim 42, wherein the stationary femoral member  
2 comprises at least one material selected from the group consisting of plastics, composites,  
3 aluminum, stainless steel, composite, cobalt-chrome, titanium, and other metals.

1           80.     A system as in claim 42, wherein the adjustable femoral member  
2 comprises at least one material selected from the group consisting of plastics, composites,  
3 aluminum, stainless steel, composite, cobalt-chrome, titanium, and other metals.

1           81.     A method for facilitating a surgical procedure on a knee, the method  
2 comprising:

3           engaging at least one femoral member with a distal femur to movably couple  
4 with a tibial member engaged with a proximal tibia, the femoral member comprising at least  
5 one stationary member and at least one adjustable member;

6           moving the knee; and

7                   adjusting the adjustable femoral member to apply tension to at least one of the  
8 ligaments of or adjacent the knee, thus moving at least one positioning feature of the  
9 adjustable femoral member relative to the distal femur to identify at least one position on the  
10 distal femur for facilitating completion of the surgical procedure.

1                   82.     A method as in claim 81, further comprising engaging the tibial  
2 member with the proximal tibia.

3                   83.     A method as in claim 82, wherein engaging the tibial member  
4 comprises selecting the tibial member from a plurality of tibial members with different  
5 dimensions, the selected tibial member having dimensions to apply a desired amount of  
6 tension to the at least one ligament.

1                   84.     A method as in claim 81, wherein the tibial member is engaged with a  
2 cut surface of the proximal tibia, and wherein the femoral member is engaged with a cut  
3 surface of the distal femur.

1                   85.     A method as in claim 84, wherein the tibial and femoral members are  
2 engaged primarily within a joint space between the cut surfaces of the proximal tibia and the  
3 distal femur.

1                   86.     A method as in claim 81, wherein engaging the femoral member  
2 comprises attaching the stationary member to the distal femur, and wherein an adjustable  
3 portion of the femoral member is coupled with the stationary portion.

4                   87.     A method as in claim 81, wherein moving the knee comprises moving  
5 from approximately full extension to approximately full flexion.

1                   88.     A method as in claim 81, wherein moving the knee comprises moving  
2 from approximately full flexion to approximately full extension.

1                   89.     A method as in claim 81, wherein moving the knee comprises sliding  
2 at least one posterior condylar member of the femoral member along at least one  
3 complementary depression in the tibial member.

1                   90.     A method as in claim 81, wherein moving the knee comprises sliding  
2 the femoral member along the tibial member.

3           91.     A method as in claim 81, further comprising:  
4           moving the knee after the adjusting step; and  
5           further adjusting the adjustable femoral member.

1           92.     A method as in claim 81, wherein at least the moving and adjusting  
2           steps are performed with a patella of the knee located approximately its anatomic position  
3           over the knee.

1           93.     A method as in claim 81, further comprising moving the knee through  
2           the range of motion to help determine the desired ligament tension balance in the knee during  
3           the range of motion.

1           94.     A method as in claim 93, wherein moving the knee through the range  
2           of motion comprises moving the knee from approximately full extension to approximately  
3           full flexion or vice versa.

1           95.     A method as in claim 81, wherein adjusting the adjustable femoral  
2           member comprises adjusting tension in at least one of a medial collateral ligament and a  
3           lateral collateral ligament.

1           96.     A method as in claim 81, wherein adjusting the adjustable femoral  
2           member comprises enlarging a joint space between at least part of the distal femur and  
3           proximal tibia to apply tension to at least one of the ligaments.

1           97.     A method as in claim 96, wherein enlarging the joint space comprises  
2           enlarging the space primarily at a medial side of the knee.

1           98.     A method as in claim 96, wherein enlarging the joint space comprises  
2           enlarging the space primarily at a lateral side of the knee.

1           99.     A method as in claim 96, wherein enlarging the space applies tension  
2           to at least one of a medial collateral ligament and a lateral collateral ligament.

1           100.    A method as in claim 96, wherein the adjustable femoral member is  
2           adjusted relative to the stationary femoral member and relative to the distal femur.

1           101.    A method as in claim 100, wherein adjusting the adjustable femoral  
2           member comprises adjusting at least one adjustment member.

1           102. A method as in claim 101, wherein adjusting the adjustment member  
2 comprises turning at least one screw.

1           103. A method as in claim 81, wherein adjusting the adjustable femoral  
2 member to move the at least one positioning feature facilitates at least one of placing a  
3 cutting guide on the distal femur for making bone cuts, making one or more bone cuts on the  
4 distal femur, and positioning a prosthetic femoral component on the distal femur.

5           104. A method as in claim 103, further comprising determining a position  
6 for placing a cutting guide on the distal femur to make at least one cut on the femur, based on  
7 the relative position of the at least one positioning feature.

1           105. A method as in claim 103, further comprising determining a position  
2 for placing at least one bone cut on the distal femur, based on the relative position of the at  
3 least one positioning feature.

1           106. A method as in claim 103, further comprising determining a position  
2 for placing a prosthetic femoral component on the distal femur, based on the relative position  
3 of the at least one positioning feature.

1           107. A method as in claim 103, wherein the at least one positioning feature  
2 is selected from the group consisting of an aperture, a drill bit guide, a surface marker, a  
3 surface feature, a measurement device, an embedded marker, a fiducial, a transponder, a  
4 transceiver and a sensor.

1           108. A method as in claim 107, wherein the at least one aperture comprises  
2 at least two apertures, and wherein adjusting the adjustable femoral member causes the at  
3 least two apertures to rotate relative to one another over the distal end of the femur.

1           109. A method as in claim 108, wherein the apertures rotate about an axis  
2 approximately corresponding to a long axis of the distal femur.

1           110. A method as in claim 108, wherein adjusting the adjustable femoral  
2 member causes the at least one aperture to move in an anterior or posterior direction relative  
3 to the distal femur.

1           111. A method as in claim 108, further comprising:

2 drilling at least one hole in the distal end of the femur, using the at least one  
3 aperture to guide a drill bit;  
4 removing the adjustable femoral member from the distal femur;  
5 attaching a cutting guide to the distal end of the femur, using the at least one  
6 drilled hole; and  
7 making at least one cut on the distal end of the femur, using the cutting guide.

1 112. A method as in claim 111, further comprising:  
2 attaching a femoral prosthesis component to the cut distal end of the femur;  
3 and  
4 attaching a tibial prosthesis component to a cut surface of the proximal tibia.

1 113. A method as in claim 107, further comprising:  
2 sending one or more signals from the at least one positioning device to a distal  
3 femur cutting device; and  
4 cutting the distal femur with the cutting device, based on the signal(s).

1 114. A method as in claim 113, wherein the distal femur cutting device  
2 comprises a robotic device.